

Fisheries Report 05-11

SURVEY OF THE TROUT FISHERY IN THE HIWASSEE RIVER March – October 2004



A Final Report Submitted To

**Tennessee Wildlife Resources Agency
Nashville, Tennessee**

By

**Phillip W. Bettoli, Ph.D.
Tennessee Cooperative Fishery Research Unit
Tennessee Technological University
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EXECUTIVE SUMMARY

1. The trout fishery in the 18 km of the Hiwassee River between the Apalachia Powerhouse and the Highway 411 Bridge was surveyed between March and October 2004 using a roving creel survey. The river was last surveyed in 1999. In 2004 the river was stocked with 14,071 150-mm total length (TL; 6-inch) brown trout, nearly 15,000 fingerling (~ 100 mm TL) brown trout, and 83,136 catchable (≥ 225 mm TL) rainbow trout.
2. Fishing pressure over the 8-month survey totaled 42,952 h (90% confidence interval, $\pm 6,776$). Fishing pressure over comparable 8-month periods was 61% higher in 1999 than in 2004. The estimated number of fishing trips was much lower in 2004 (11,450 trips) than in 1999 (19,298 trips over 8 months).
3. The catch rate for trout in 2004 was high, averaging 1.34 trout/hour (SE = 0.09) for completed-trip anglers fishing longer than 1 hour; the catch rate was significantly lower in 1999 (1.21 fish/hour; SE = 0.09; $P = 0.010$; Wilcoxon two-sample test). The harvest rate was low (0.37 fish/hour; SE = 0.05) and had not changed since 1999 (0.35 fish/hour; SE = 0.04; $P = 0.624$).
4. The estimated catch of rainbow trout was 45,923 fish. The number of rainbow trout harvested (15,308) was 33% of the total number caught.
5. Few brown trout were caught (5,151) and even fewer were harvested (220) during the 2004 survey.

6. The number of trout harvested by anglers who had completed fishing when interviewed averaged 1.21 (SE = 0.14) trout per angler per trip. Those same anglers reported catching an average of 4.97 (SE = 0.39) trout per angler per trip.

7. The clerk observed nearly 1,000 rainbow trout in the creel; only three of those fish were longer than 356 mm (14 inches) total length (TL). Few ($n = 12$) brown trout were observed in the creel and most ($n = 10$) were illegal (shorter than 356 mm TL).

8. Sixty-seven percent of the 1,131 anglers interviewed were Tennessee residents (compared to 88% in 1999). The remainder lived in 25 other states and two countries. Most (55%) of the Tennessee residents lived in four counties near the Hiwassee River (Bradley, Hamilton, McMinn, and Polk); the remainder lived in 31 other counties.

9. As in 1999, most (67%) of the anglers interviewed in 2004 were using some form of artificial lures or flies, not bait. Fly fishermen represented a higher percentage of interviewed anglers in 2004 (37%) than in 1999 (30%).

10. The Hiwassee River trout fishery remained a destination fishery for Tennessee residents and out-of-state anglers in 2004. All measures of fishing quality (e.g., catch rates, harvest rates) remained similar or increased since 1999. No information is available to explain the drop in fishing pressure since 1999, particularly in the spring. Similarly, no information is available to suggest that the decline in fishing pressure is anything other than random variation in fishing effort among years.

INTRODUCTION

The Hiwassee River below Apalachia Powerhouse in southeast Tennessee has been a popular trout fishery for several decades. In 2004 the Tennessee Wildlife Resources Agency (TWRA) stocked the river with 83,136 catchable (> 225 mm total length, TL) rainbow trout, 14,991 fingerling (100 mm TL) brown trout, and 14,071 brown trout that averaged about 150 mm TL. The stocking rate in 2004 was slightly less than in 2003, when the TWRA stocked more catchable rainbow trout (90,237) and more catchable brown trout (22,201). About equal numbers of fingerling brown trout were stocked in each of the last two years. Bettoli (1989) conducted a creel survey in the mid-1980s and noted low return rates for trout stocked into the Hiwassee River. Fishing pressure was estimated again in 1999 and the fate of stocked rainbow trout and brown trout was first described by Luisi and Bettoli (2001). The river regularly experiences elevated (> 22 C) water temperatures each summer, which limits the ability of the tailwater to support large numbers of holdover trout. The waters of the Hiwassee River are also low in dissolved solids and nutrients, which limits the carrying capacity of the system for trout and other fish species. Nevertheless, the Hiwassee River is a destination trout fishery that is highly valued by many anglers from a broad geographical area, particularly fly fishermen (Luisi and Bettoli 2001; Hutt and Bettoli 2003). In fact, the total value of the Hiwassee River trout fishery (expenditures plus net value) in 2001 was second only to the trout fishery in the Caney Fork River in Tennessee (Williams and Bettoli 2003).

STUDY AREA

Apalachia Dam is located on the Hiwassee River (HR) at river kilometer 106 (HRkm 106) in Cherokee County, North Carolina, approximately 50 km east of Cleveland, Tennessee. The Tennessee Valley Authority (TVA) completed construction of the dam in 1943 and it impounds Apalachia reservoir. At normal pool the reservoir has a surface area of about 440 ha. Unlike most tailwater systems, the discharge from Apalachia Dam enters an aqueduct and is piped approximately 14 km downstream to the Apalachia Powerhouse at HRkm 86 in Polk

County, Tennessee. At full generation, this two-turbine facility releases approximately 80 m³/s (2,850 cfs) with an additional flow of approximately 2 m³/s (80 cfs) from the old river channel.

The Hiwassee River harbors both warmwater and coldwater species; however, salmonids are the dominant sportfish species in the tailwater. Rainbow trout and brown trout accounted for 97 percent of the fish harvested in 1995 (Scott et al. 1996) and nearly all anglers in the 1999 survey were targeting trout. State trout regulations allow anglers to harvest seven trout daily (maximum of two brown trout daily) on the Hiwassee River in all areas other than the Quality Zone, which is a 6-km section in the upper reach of the tailwater. Quality Zone regulations include a 356 mm (14 inch) minimum length limit and a daily limit of two trout. Also, the use of any bait other than artificial lures is prohibited in the Quality Zone. Effective March 1, 2004, fishing regulations for the Hiwassee River prohibited the harvest of brown trout shorter than 356 mm TL anywhere on the river.

Historically, high water temperatures and low dissolved oxygen (DO) levels (< 6 mg/l) occurring in late summer and early fall and were considered to be limiting the trout populations in the Hiwassee River (Scott et al. 1996). To alleviate these problems, TVA implemented a year round minimum flow regulation (6 m³/s; 200 cfs) in 1991, which is accomplished by pulsing one of the two turbines for one hour every four hours. Also, hub baffles were installed on the turbines in 1993 to aerate the discharge (Scott et al. 1996). These modifications were successful and reduced the number of deficit days (number of days that the target DO level of 6 mg/l was not met, multiplied by the number of mg/l below the target level) from 54 d to less than 1 d.

The upper section of the tailwater below Apalachia Powerhouse is classified as a Class II whitewater river and receives heavy non-angling recreational use during the summer months. This area is also the only section of the tailwater that provides easy access for bank fishing and suitable depths for wading during periods of no generation. In 1995, TVA initiated a minimum flow consisting of full generation between 11 AM and 7 PM from Memorial Day until the end of August to benefit canoeist and rafters. Although the recreation flows limit fishing opportunities for wading anglers, it provides excellent floating conditions for anglers in rafts and drift boats.

The trout fishery in the Hiwassee River is primarily a stocked fishery. No reproduction by either trout species was detected by Banks and Bettoli (2000); lack of suitable substrate, poor body condition, and high water levels during the winter spawning seasons were thought to be responsible for the lack of trout spawning. Some trout (principally brown trout) overwinter each year, but the standing crop of overwintering trout is the lowest of any tailwater fishery in Tennessee (Luisi and Bettoli 2001; Meerbeek and Bettoli 2005).

METHODS

Creel Survey

A stratified non-uniform probability roving creel survey was conducted between 1 March 2004 and 31 October 2004. The 8-month survey was designed to collect information on the amount of fishing pressure the tailwater was receiving, the catch and harvest rates of rainbow trout and brown trout, and the catch per unit of effort by anglers. The survey closely followed the survey design used in 1999. The survey was stratified by month and kind-of-day. Six to nine weekdays and eight to eleven weekends and holidays were surveyed each month. Sampling days were divided into three equal-length work periods based on sunrise and sunset times. The river was stratified into two areas: the powerhouse to Reliance was Area 1 and the reach from Reliance to the State Highway 411 bridge was Area 2. Area 1 was sampled with a probability of 60% between March and mid-May and 70% thereafter; these probabilities reflected differences in fishing pressure observed in the 1999 survey. The three work shifts each day were sampled with equal probability (33%) throughout the entire survey. The clerk counted anglers in the area being surveyed once each work shift. The time to start the count was randomly selected from a list of possible start times for each shift, beginning at the start of each shift and every 30 minutes thereafter until 1 h before the end of the shift. The counts were adjusted upwards when more boat trailers were counted than boats; two anglers were added to the count for each boat that was presumed to be on the river, but was not observed.

Before and after the count, the clerk interviewed anglers. If anglers agreed to be interviewed, they were asked how long they had been fishing that day, whether they were finished fishing, and how many trout they had caught. Anglers were asked their state of residency and Tennessee residents were also asked for their county residence. The clerk also recorded the method of fishing used by each angler. A copy of the interview sheet is provided in Appendix I.

Mean daily counts were expanded to estimate effort in each stratum (i.e., kind-of-day) and were then pooled to estimate effort each month following the methods of Pollock et al. (1994). Catch and harvest rates were measured using the mean of ratios method, which is recommended for roving creel surveys (Pollock et al. 1997); interviews of parties that had been fishing for less than one hour were excluded from the analysis. Catch and harvest of each trout species was then estimated for each month. Standard errors of catch, harvest, and effort each two-week period were calculated according to Pollock et al. (1994). A spreadsheet performed all necessary calculations and calculated confidence intervals around each estimate of catch, harvest, and effort. The pooled standard error (SE) for total pressure, total harvest, and total catch of each species was calculated using the mean-square-successive-difference-between-periods procedure:

$$SE = \sqrt{\frac{N}{2(N-1)} \sum (X_{i+1} - X_1)^2}$$

where N = number of sample periods (months)

X = estimate for each month.

The SE was multiplied by 1.67 and then added and subtracted to the estimates to generate approximate 90% confidence intervals.

The average number of trout harvested by complete-trip anglers and incomplete-trip anglers was compared using the Wilcoxon rank-sum test. Complete-trip and incomplete-trip

anglers did not differ in the rates at which they harvested trout (both species combined; $P = 0.827$); therefore, the data from all interviews were pooled.

The results of this survey were compared to creel survey results obtained for the Hiwassee River when it was last surveyed in 1999 (Luisi and Bettoli 2001).

The 2004 survey differed from the 1999 in two ways. Clerks in 2004 did not visit the Patty Bridge access point because few anglers were encountered in 1999 at that remote ramp downstream of the Highway 411 bridge. Secondly, each workday was divided into thirds for the 2004 survey instead of half-days.

RESULTS and DISCUSSION

Fishing Pressure

Fishing pressure over the eight-month survey totaled 42,952 h (90% confidence limits $\pm 6,776$; Table 1). Average trip length was 3.72 (SE = 0.14) hours; thus, anglers made 11,450 trips to the tailwater during the 2004 survey period. Fishing pressure over comparable 8-month periods was 61% higher in 1999 and the estimated number of fishing trips was much higher in 1999 (19,298 trips over 8 months). Average daily discharge through the turbines at the Apalachia Powerhouse during the survey period was higher in 1999 than in 2004 (Figure 1). Thus, lower fishing pressure in 2004 cannot be attributed to higher flows during the survey period. Fishing pressure during the 1999 Hiwassee River survey was inversely related to turbine discharge each two-week period (Luisi and Bettoli 2001) and an inverse relationship between river flows and fishing pressure among years is common on other Tennessee tailwaters (e.g., Caney Fork River; Bettoli 2004); however, that relationship apparently does not exist on the Hiwassee River.

The decline in fishing pressure between 1999 and 2004 was not due to less fishing pressure in Area 1 (where most of the pressure historically occurs) during the “peak” (late spring-early summer) fishing season on the Hiwassee River. The average instantaneous counts in Area 1 on weekends (when most of the pressure occurs) between late April and late July

were nearly identical in the 1999 and 2004 surveys (24.7 and 25.7, respectively). Instead, much of the decline in fishing pressure between 1999 and 2004 was due to fewer anglers visiting the river in early spring. That is, instantaneous counts of anglers in Area 1 on weekends between March 1 and May 7 were nearly three times higher in 1999 (34.7) than in 2004 (12.1). Average counts in Area 2 on weekends in early spring declined only slightly between 1999 (11.6) and 2004 (9.2). River flows were lower in early spring (March 1 – May 7) in 2004 ($12 \text{ m}^3/\text{s}$) than in 1999 ($18 \text{ m}^3/\text{s}$); thus, it appears (again) that there was no relationship between average discharge each season and fishing pressure on the Hiwassee River. No information is available to explain why fishing pressure was so light in the spring of 2004.

Catch and Harvest

The number of rainbow trout and brown trout that anglers reported catching during the 2004 survey totaled 45,923 and 5,151 fish, respectively (Table 1). Anglers reported high catch rates throughout the survey. The pooled catch rate (both species; complete-trip parties fishing more than 1 hour) averaged 1.34 trout/h (SE = 0.09), which was significantly higher than the pooled catch rate of 1.21 fish/h in 1999 (Wilcoxon test: $P = 0.010$). The catch rate was higher in 2004 despite the fact that about 21,000 more catchable trout were stocked in 1999. TWRA's strategy after 1999 to stock fewer fish, but at more frequent intervals, appears to be working in terms of maintaining high catch rates. The harvest rate was similar during both surveys (0.35-0.37 fish/h; $P = 0.625$).

More than 15,000 rainbow trout were harvested during the 2004 survey, compared to 17,537 rainbow trout in 1999 over comparable 8-month periods. The difference between the number of rainbow trout harvested in 2004 and the number caught represented a release rate of 67%, which was similar to the release rate in 1999 (65%). The release rate for brown trout in 2004 was much higher (96%) and represented an increase since 1999, when the release rate was 89%.

The mean number of trout harvested by complete-trip anglers in 2004 was 1.21 trout per angler per trip (SE = 0.14; $n = 229$ parties; Figure 2), which was comparable to the harvest

rate-per-trip in 1999 (1.15 fish per angler; SE = 0.11). Thirty-two percent of fishing parties interviewed were responsible for all of the harvest observed during the 2004 survey. Anglers reported catching 4.97 trout per angler per trip in 2004 (SE = 0.39), which represented a slight increase since 1999 (4.33 fish caught per angler per trip). Only 17% of complete-trip parties failed to catch a fish in 2004, down from 28% in 1999.

The total lengths of rainbow trout harvested by anglers reflected the size distribution of rainbow trout stocked throughout the year. Most (91%) of the rainbow trout observed in the creel measured 30 cm TL or shorter (Figure 3). The clerk measured three rainbow trout longer than 30 cm TL, which represented 0.36% of all rainbow trout measured. Thus, an estimated 55 rainbow trout ($0.0036 \times 15,308$ harvested rainbow trout) longer than 35 cm TL were harvested during the 8-month survey in 2004. The creel clerk observed only 12 brown trout in the creel, of which 10 were clearly holdover fish because they were longer than 25 cm TL (Figure 3), and nine were illegal.

Angler Characteristics

Sixty-seven percent of the 1,131 anglers interviewed on the Hiwassee River in 2004 were Tennessee residents, which was less than the 88% residency rate in 1999. Out-of-state anglers traveled from Georgia (17% of all interviewed anglers) and 25 other states, including two foreign countries. Local residents (i.e., living in Bradley, McMinn Hamilton, and Polk counties) accounted for barely half (55%) of all Tennessee residents fishing the river; in most other tailwater fisheries in Tennessee, local anglers outnumber visiting anglers by a much wider margin. Tennessee anglers fishing the Hiwassee River in 2004 resided in 31 counties.

The percentage of anglers fishing with artificial lures and flies increased slightly between 1999 (61%) and 2004 (67%). Similarly, the percentage of anglers using flyfishing gear rose from 30% to 37% between 1999 and 2004. Among Tennessee's tailwater trout fisheries, the Hiwassee River ranks third in percentage of anglers using flyfishing gear behind the Elk River in 2000 (65%; Bettoli 2001) and Watauga River fishery in 2002 (47%; Bettoli 2003)

CONCLUSIONS

The Hiwassee River trout fishery remained a destination fishery for Tennessee residents and out-of-state anglers in 2004. All measures of fishing quality (e.g., catch rates, harvest rates; percent of trips in which at least one trout was caught) remained similar or increased since 1999. Stocking fewer fish but at greater frequency throughout much of the year appears to be a sound strategy to maintain fishing quality. No information is available to explain the drop in fishing pressure since 1999, particularly in the spring. Similarly, no information is available to suggest that the decline in fishing pressure is anything other than random variation in fishing effort among years.

ACKNOWLEDGMENTS

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Table 1. Fishing pressure and number of rainbow trout and brown trout caught and harvested by anglers fishing the Hiwassee River, Tennessee, March – October 2004. Mean catch-per-unit-effort rates based on interviews of all parties that had been fishing at least 1 hour.

Month	Pressure (hours)	SE	Rainbows Caught	SE	Rainbows Harvested	SE	Browns Caught	SE	Browns Harvested	SE	Mean CPUE
March	5,383	1,175	3,369	1,193	1,359	782	291	176	0	-	0.94
April	5,161	998	4,754	1,313	1,270	363	2,575	2,042	90	64	2.34
May	6,245	1,499	7,533	1,847	2,396	777	577	278	0	-	1.17
June	6,722	1,400	8,212	2,114	2,621	696	263	110	14	10	1.26
July	8,755	1,690	11,909	3,555	4,064	1,206	876	335	76	52	1.75
August	5,374	1,308	5,118	1,682	2,334	1,159	134	87	0	-	0.80
September	1,819	532	1,813	737	872	364	173	95	36	31	0.95
October	3,133	704	3,215	1,022	392	112	262	183	4	4	1.23
TOTAL	42,592	4,235	45,923	6,878	15,308	2,239	5,151	2,419	220	127	1.34

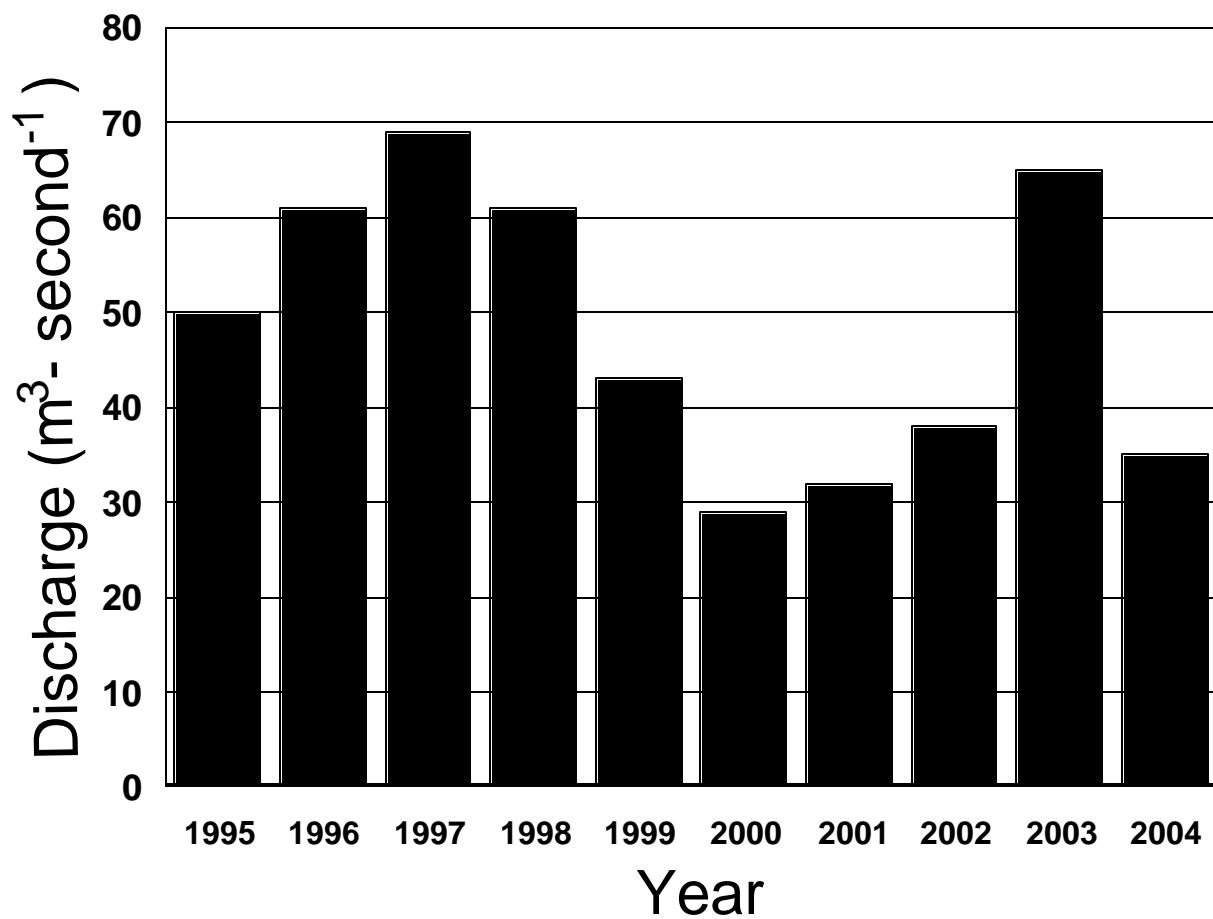


Figure 1. Average discharge through the Apalachia Powerhouse turbines between 1 March and 31 October, 1995-2004.

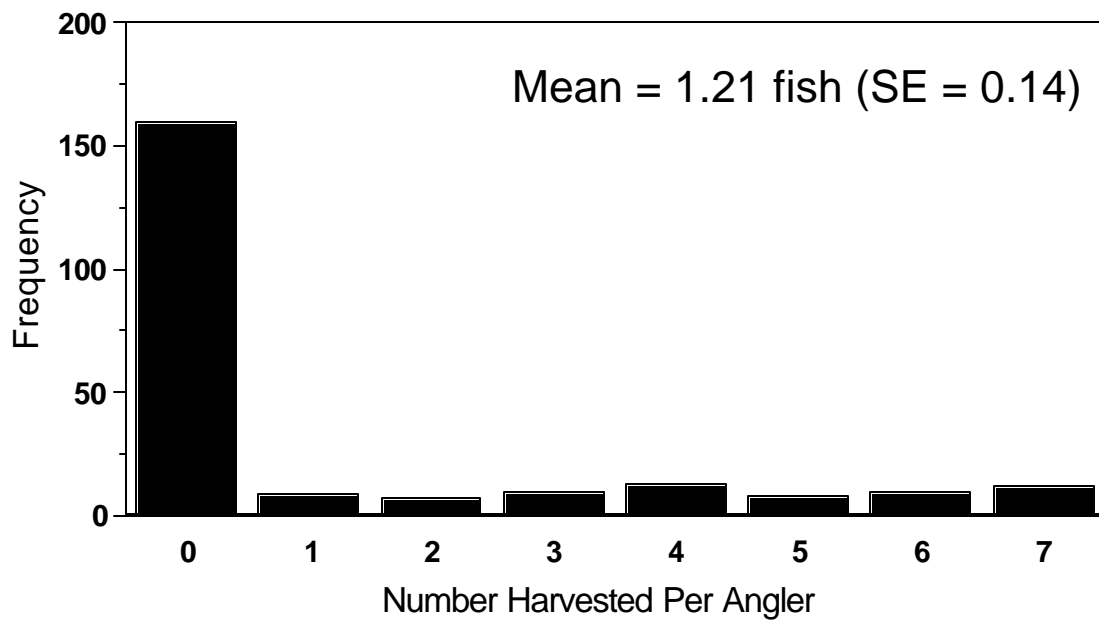
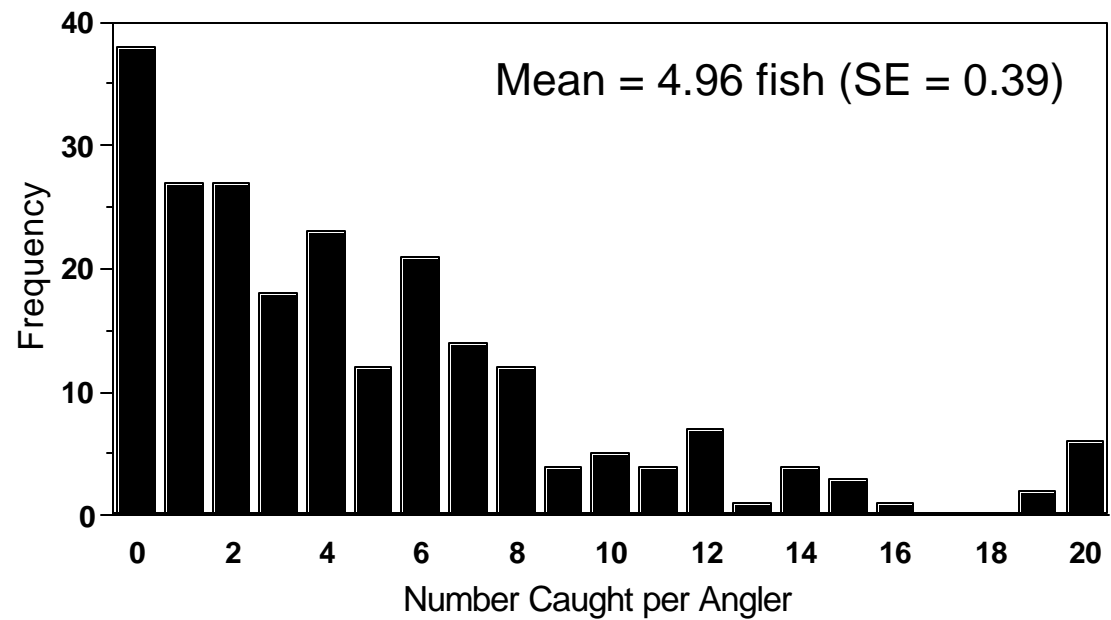


Figure 2. Average number of trout harvested and caught by anglers of parties that had completed fishing on the Hiwassee River, March- October 2004. N = 229 parties.

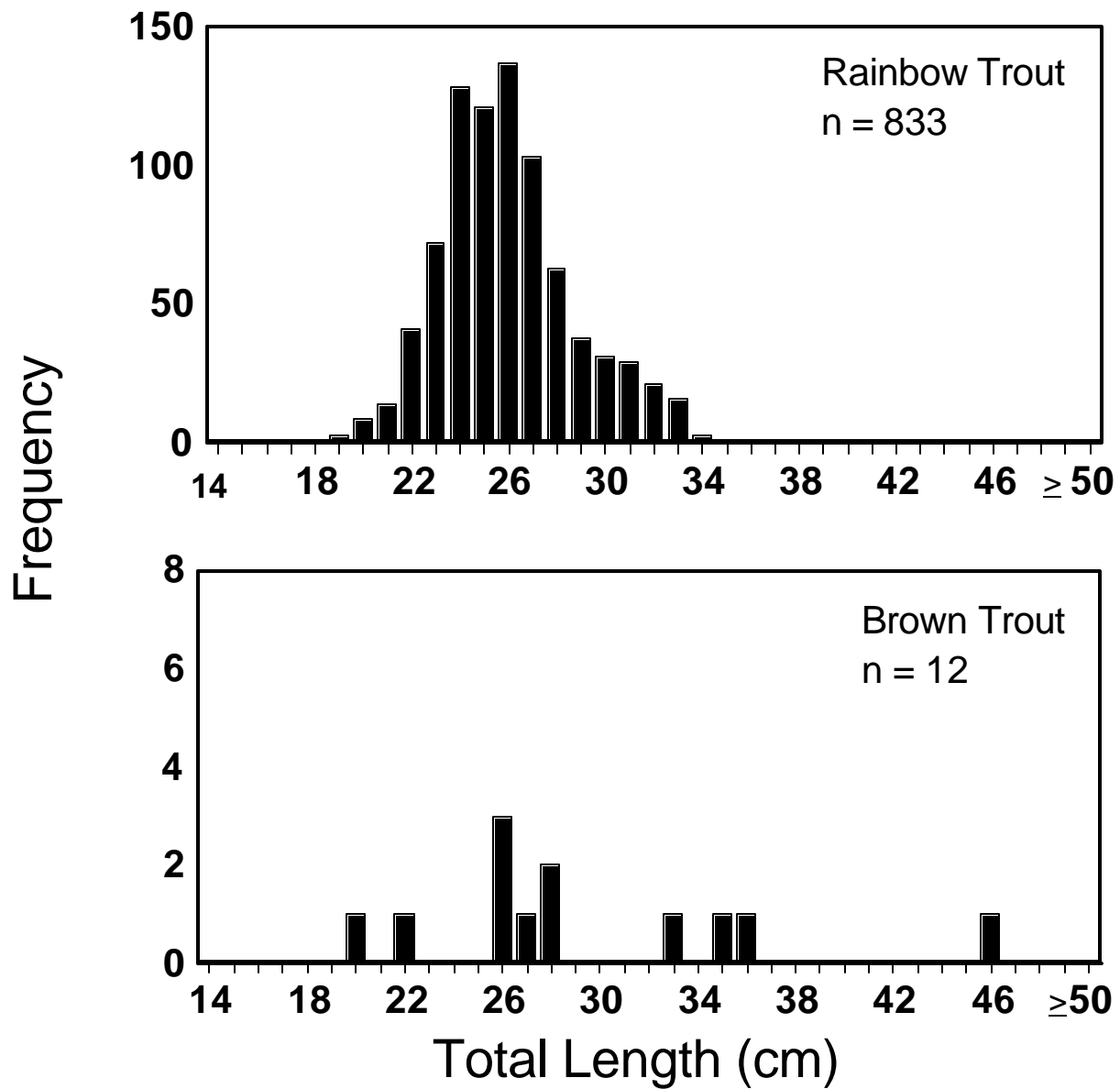


Figure 3. Length-frequency distributions for rainbow trout and brown trout harvested by anglers on the Hiwassee river, March – October 2004.

APPENDIX

Survey forms used during the creel survey on the Hiwassee River, 2004

DAILY SAMPLE SHEET - HIWASSEE 2004

DATE (mm/dd/year) _____

KIND OF DAY _____
(01 = weekday 02= weekend)

AREA 1 [upper] OR 2 [lower]) _____ SHIFT (1st, 2nd, 3rd) _____

TIME COUNT BEGAN _____
(military time)

RIVER STAGE IN WORK AREA _____
WHEN COUNT BEGAN (0 = NO GENERATION, 1 = GENERATION)

Anglers			Boats	Trailers
Spin	Fly	Unknown		
Area 1				

Above Quality
Zone

Quality
Zone

Area 2

Reliance –to-
Hwy 411

TOTALS	_____	_____	_____	_____	_____
	Spin	Fly	Unknown	Boats	Trailers

“Boats” refers to any drift boats or jonboats with people fishing in them.

“Trailers” refers to any trailer used to haul a drift boat or jonboat.

Number of Anglers (not including guide) per boat _____

INTERVIEW SHEET - HIWASSEE RIVER 2004

DATE (MM/DD/YEAR) _____ INTERVIEW NUMBER _____

KIND-OF-DAY _____

Weekday = 01 Weekend / holiday = 02

ACCESS POINT (1, 2, or 3) _____ NUMBER IN PARTY _____

1 = Above QZ, 2 = QZ 3 = Below Reliance

START OF FISHING _____ END OF FISHING _____
(or Time of interview)

Time Fishing HR COMPLETED TRIP?

By Party YES = 1 NO = 2

MIN

SPECIES FISHED FOR: CHECK ONE TROUT _____ OTHER or ANY _____

(1)

(2)

Number of RAINBOWS CAUGHT _____ Number of RAINBOWS KEPT _____

LENGTHS OF RAINBOWS (nearest cm)

Number of BROWNS CAUGHT _____ **Number of BROWNS KEPT** _____

LENGTHS OF TAGGED BROWNS (nearest cm)

For METHOD, TERMINAL GEAR, and LOCATION, the numbers entered should equal the number in the party.

METHOD: STILLFISHING _____ SPINFISHING _____ FLYFISHING _____

TERMINAL GEAR: ARTIFICIAL LURES or FLIES BAIT

LOCATION: ON BANK/WADING _____ IN BOAT _____ FLOAT-TUBE _____

STATE _____ AND COUNTY (IF TN) _____